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Chromosomes of Garden Roses

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KNOWLEDGE of the chromosome number of a particular rose variety is often of the greatest practical importance to the rose breeder when planning his hybridizing program, in addition to the information that cytological study of the garden roses has given us about the evolution of this genus during its long period of cultivation. The following table, therefore, brings together the chromosome numbers determined by myself (these have the index-number [1] next to the chromosome number), together with those previously published, their index-numbers [2] to [12] corresponding to the numbered references in the bibliography at the end. The total of 234 varieties covers all the major groups, ancient and modern. The sources of my material are given in the third column of the table and the key to the letters used as abbreviations is as follows:

B. John Innes Horticultural Institution, Bayfordbury, Herts.
K. Royal Botanic Gardens, Kew.
O. National Rose Society's Trial Grounds, Oaklands, St. Albans.
S. Col. F. C. Stern, Highdown, Goring-by-Sea, Sussex.
T. G. S. Thomas, Hilling's Nurseries, Chobham, Surrey.
W. Royal Horticultural Society's Gardens, Wisley, Surrey.

The varieties in any one class are subdivided according to degree of polyploidy and arranged chronologically within each subdivision. Details about origins are taken principally from *Modern Roses IV*.

TABLE 1

CHROMOSOME NUMBERS OF GARDEN ROSES

Variety	Chr. no.	Source of material	Origin	Date of introduction & Breeder
CHINA ROSES				
(i) *Diploid*				
Miss Lowe's	14[1]	T.	(Old Single Red *Rosa chinensis*)	
Single Pink	" "	T.		
mutabilis	" [9]			
Old Blush China	" [8]			1793 (Parsons)
Le Vesuve	" [1]	T.		1825 Laffay
Violet Bengal Rose	" "	W.		1827
Némésis	" "	T.		1836 Bizard
Mme. L. Messimy	" "	W.		1887 Guillot
Aurore	" "	T.		1897 Schwartz
minima Oakington Ruby	" "	B.		1933 Bloom
" Pink Nymph	" "	B.		
(ii) *Triploid*				
Hermosa	21[1]	T., W.		1840 Marcheseau
Cl. Cramoisi Supérieur	" "	W.	(Sport of Cramoisi Supérieur)	1885 Coutourier
NOISETTE ROSES				
(i) *Diploid*				
Champney's Pink Cluster	14[1]	T.	(*R. chinensis* × *R. moschata*)	1816 Champney
Blush Noisette	" [8]		(F_2 from above cross)	1819 Noisette
Desprez à fl. jaunes	" [1]	T.		1838 Desprez
Céline Forestier	" "	T.		1842 Trouillard
Fortune's Double Yellow	" "	S.	(= *R. odorata pseudindica*)	1845 (Fortune)

TABLE 1 (*Continued*)

Variety	Chr. no.	Source of material	Origin	Date of introduction & Breeder
Maréchal Niel	14[1]	T.	(Chromatella × unknown) Noisette	1864 Pradel
W. A. Richardson	" "	T.	(Rêve d'Or × unknown) Noisette	1875 Ducher
Alister Stella Gray	" "	T.		1894 Paul
(ii) *Triploid*				
Mme. Plantier	21[1]	S.		1835 Plantier
Mme. Alfred Carrière [(1)]	21[1] / 28[7]	T.		1879 Schwartz
(iii) *Tetraploid*				
Gloire de Dijon	28[1, 7, 10]	T.	(Souv. de la Malmaison × a Tea) Bourbon	1850 Jacotot
TEA ROSES				
(i) *Diploid*				
Marie van Houttē	14[1]	Scott	(Mme. de Tartas × Mme. Falcot) Tea Tea	1871 Ducher
Anna Olivier	" "	T.		1873 Ducher
Mlle. F. Kruger	" "	T.	(C. Mermet × Gen. Schablikine) Tea Tea	1879 Nabonnand
Archduc Joseph	" "	T.	(Mme. Lombard × unknown) Tea	1892 "
Mme. Antoine Mari	" "	T.		1900 Mari
Tillier	" "	T.		
(ii) *Triploid*				
Homère	21[1]	T.		1858 Robert & Moreau

TABLE 1 (*Continued*)

Variety	Chr. no.	Source of material	Origin	Date of introduction & Breeder
Paul Nabonnand	21[1]	T.		1877 Nabonnand
Papa Gontier	" "	T.		1883 "
Comtesse F. Hamilton	" "	T.		1892 "
Noella Nabonnand	" "	T.	(Reine M. Henriette (Tea) × Bardou Job (Bourbon))	1901 "
Lady Hillingdon	" 1,7	Jackman	(Papa Gontier (Tea 3*x*) × Mme. Hoste (Tea))	1910 Lowe & Shawyer
(iii) *Tetraploid*				
Souv. de G. Nabonnand	28[1]	T.		1920 Nabonnand
BOURBON ROSES				
(i) *Triploid*				
Gloire des Rosomanes	21[4]			1825 Vibert
Souv. de la Malmaison	" [8]			1843 Béluze
Kathleen Harrop	" [1]	T.	(Sport of Zéphirine Drouhin)	1919 Dickson
Souv. de St. Anne's	" "	T.	(Sport of Souv. de la Malmaison)	1950 Hillings
(ii) *Tetraploid*				
Louise Odier	28[1]	W.		1851 Margottin
Mme. Pierre Oger	" "	T., W.	(Sport of La Reine Victoria (Bourbon))	1878 Oger
Mme. Isaac Pereire	" "	K.		1881 Garcon
Gruss an Teplitz	" "	T.	((Gl. des Rosomanes (Bourb. 3*x*) × Papa Gontier (Tea 3*x*)) × (Sir J. Paxton (Bourb.) × Fellemberg (China)))	1897 Geschwind

TABLE 1 (*Continued*)

Variety	Chr. no.	Source of material	Origin	Date of introduction & Breeder
HYBRID CHINA ROSES				
(i) *Triploid*				
"Original Hybrid China" (perhaps Brown's Superb Blush)	21 [8]			1815 Brown
(ii) *Tetraploid*				
Malton	28 [8]		(Chinensis-gallica hybrid)	1830 Laffay
Athalin	" "		(Bourbon-gallica hybrid)	" "
Brennus	" "		" " "	" "
General Allard	" "		" " " "	" "
PORTLAND ROSES				
(i) *Tetraploid*				
Rose du Roi à fl. pourpres	28 [1]	T.	(Sport of Rose du Roi) Portland	1819
HYBRID PERPETUAL ROSES				
(i) *Tetraploid*				
Général Jacqueminot	28 [1, 8, 10]	T.	(Gl. des Rosomanes × deriv. of Rose du Roi) Bourb. Portl.	1852 Rousselet
Fischer Holmes	" [1, 8, 10]	K.	(F_2 from Gén. Jacqueminot)	1865 Verdier
Antoine Ducher	" [8]			1866 Ducher
Ulrich Brunner	" [1, 10]	K.		1881 Levet
Mrs. John Laing	" [1]	T.	(Fr. Michelon × unknown) H.P.	1887 Bennett
Roger Lambelin	" "	T.	(Sport of Fischer Holmes)	1890 Schwartz
Captain Hayward	" "	W.	(Triomphe de l'Exposition × unknown) H.P.	1893 Bennett

TABLE 1 (*Continued*)

Variety	Chr. no.	Source of material	Origin	Date of introduction & Breeder
Frau Karl Druschki	28 [1, 8, 10]	W.	(Merv. de Lyon × C. Testout) H.P. H.T. 4x	1901 Lambert
HYBRID TEA ROSES (including PERNETIANAS)				
(i) *Triploid*				
La France	21 [1]	T.	(Mme. V. Verdier × Mme. Bravy) H.P. Tea	1867 Guillot
Irish Elegance	" "	W.		1905 Dickson
Gruss an Aachen [2]	" "	T.	(Frau K. Druschki × F. Deegen) H.P. 4x H.T.	1909 Geduldig
(ii) *Tetraploid*				
Mme. Caroline Testout [3]	28 [1]	W.	(Mme. de Tartas × Lady M. Fitzwilliam) Tea H.T.	1890 Pernet-Ducher
Soleil d'Or	" [8]		(F_2 from (Antoine Ducher H.P. × *R. foetida persiana*))	1900 " "
Gustav Grunerwald	" [10]		(Safrano × C. Testout) Tea H.T. 4x	1903 Lambert
General MacArthur	" [1, 2]	W.		1905 Hill
Lyon Rose	" [8, 10]		(Mme. M. Soupert × Soleil d'Or descendant) H.T.	1907 Pernet-Ducher
Louis Barbier	" [6]		(Mme. Bérard × *R. foetida bicolor*) Cl. Tea	1909
Mme. Édouard Herriot	" [1, 8]	W.	(C. Testout × Pernetiana var.) H.T. 4x	1912 Pernet-Ducher
Ophelia	" [1]	W.		1912 Paul
Red Letter Day	" [1, 7]	W.		1914 Dickson
Mme. Butterfly	" [1]	W.	(Sport of Ophelia) H.T. 4x	1918 Hill

TABLE 1 (*Continued*)

Variety	Chr. no.	Source of material	Origin	Date of introduction & Breeder
Étoile de Hollande	28[1]	T.	(Gen. MacArthur × Hadley) H.T. 4x H.T.	1919 Verschuren
Allen Chandler	" "	Jackman	(H. Dickson × unknown) H.P.	1923 Chandler
Rapture	" [3]		(Sport of Mme. Butterfly) H.T. 4x	1926 Traendly & Schenck
Lady Forteviot	" [1]	W.		1928 Cant
Talisman	" [3]		(Ophelia × Souv. de C. Pernet) H.T. 4x H.T.	1929 Montgomery
Mevrouw G. A. van Rossem	" "		(Souv. de C. Pernet × Gorgeous) H.T. H.T.	1929 van Rossem
Soeur Thérèse	" [9]		((Gén. Jacqueminot × Juliet) H.P. 4x H.T. × Souv. de C. Pernet) H.T.	1931 Gillot
Comtesse Vandal	" [3]		((Ophelia × Mrs. A. Ward) H.T. 4x H.T. × Souv. de C. Pernet)	1932 Leenders
Condesa de Sástago	" [1]	T.	((M. McGredy × Maréchal Foch seedling) H.T. Dw. Poly. × Souv. de C. Pernet)	1934 Dot
McGredy's Triumph	" [3]		(21/262 × Admiration) H.T.	1934 McGredy
Crimson Glory	" [1]	T., W.	(C. Kordes × W. E. Chaplin) H.T. H.T.	1935 Kordes
Violinista Costa	" "	W.		1937 Nadal
New World	" "	T.	(Crimson Glory × Château de Clos Vougeot) H.T. 4x H.T.	1945 Jacobus
Peace	" "	K.	(J. Hill × (M. McGredy × C. P. Kilham)) H.T. H.T. H.T.	1946 Meilland

TABLE 1 (*Continued*)

Variety	Chr. no.	Source of material	Origin	Date of introduction & Breeder
Tally Ho	28 [1]	T.	(C. Armstrong × H.T. seedling) H.T.	1948 Swim
DWARF POLYANTHA ROSES (i) *Diploid*				
Pâquerette	14 [7]		(F_2 from (*R. multiflora* × Dwarf Pink China))	1875 Guillot
Mignonette	" [12]		" " " " × " " "	1881 "
Cécile Brunner	" [1]	T.	(*R. multiflora* × Mme. de Tartas (or Souv. d'un Ami)) Tea Tea	1881 Ducher
Perle d'Or	" "	T.	(*R. multiflora* × Mme. Falcot) Tea	1884 Dubreuil
Mme. Norbert Levavasseur	" "	Kordes	(Crimson Rambler × Gl. des Polyanthas) Mult. 2x Dw. Poly.	1903 Levavasseur
Louise Walter	" [10]		(Tausendschön × Rosel Dach) Mult.	1909 Walter
Orleans Rose	" [1, 2]	W.	(Mme. N. Levavasseur × Polyantha seedling) Dw. Poly. 2x	1909 Levavasseur
George Elger	" [10]			1912 Turbat
Eugène Elger	" "			
Éblouissant [(3)]	" [7]		(a China var. × Cramoisi Supérieure) China 3x	1918 Turbat
Mevrouw Nathalie Nypels	" [1]	W.	(Orleans Rose × (Comtesse du Cayla Dw. Poly. 2x China × Jaune Bicolor))	1919 Leenders
Sunshine	" "	Chaplins	(G. Elger × W. A. Richardson) Dw. Poly. 2x Nois. 2x	1927 Cutbush
Paul Crampel	" "	T.		1930 Kersbergen

TABLE 1 (*Continued*)

Variety	Chr. no.	Source of material	Origin	Date of introduction & Breeder
HYBRID POLYANTHA ROSES				
			Section I: H.T. × Dw. Poly.	
Rödhätte	21 [1]	Chaplins	(Mme. N. Levavasseur (Dw. Poly. 2x) × Richmond (H.T.))	1912 Poulsen
Else Poulsen	" "	T., W.	(Orleans Rose (Dw. Poly. 2x) × Red Star (H.T.))	1924 "
Kirsten Poulsen	" "	T., W.	(" (" 2x) × " ("))	1924 "
D. T. Poulsen	" [3]		(Orleans Rose (Dw. Poly. 2x) × Vesuvius (H.T.))	1930 "
Red Else Poulsen	" [1]	K.	(Sport of Else Poulsen)	1934 Koopman
Else's Rival	" "	W.	(" " " ")	1937 Boer
Poulsen's Yellow	" "	K.	(Mrs. W. H. Cutbush (Dw. Poly.) × Gottfried Keller (H.T.))	1938 Poulsen
Kirsten Poulsen Improved	" "	K.	(Sport of Kirsten Poulsen)	1949 Radmore
Irene of Denmark	" "	O.	(Mrs. W. H. Cutbush (Dw. Poly.) × Edina (H.T.))	1951 Poulsen
Poulsen's Crimson	21 + fragment [1]	O.		1951 "
			Section II: Original H. Polys. backcrossed to H.T.'s	
Karen Poulsen	28 [1]	T., W.	(Kirsten Poulsen (H. Poly. I 3x) × Vesuvius (H.T.))	1932 Poulsen
Donald Prior	" "	Wheatcroft	(D. T. Poulsen (H. Poly. I 3x) × seedling)	1934 Prior
Poulsen's Pink	" "	"	(Golden Salmon × yellow Pernetiana (Dw. Poly.))	1939 Poulsen
Dainty Maid	" "	"	(D. T. Poulsen (H. Poly. I 3x) × unknown)	1938 Le Grice
Folkestone	" "	W.		1938 Archer

TABLE 1 (*Continued*)

Variety	Chr. no.	Source of material	Origin	Date of introduction & Breeder	
Herzblut (syn. Commonwealth)	28[1]	O.	(Holstein × Col. O. Meyer) H. Poly. II H.T.	1943	Kordes
Wilhelm Teetzmann	" "	O.	(Holstein × Crimson Glory) H. Poly. II H.T. 4x	1943	"
August Seebauer	" "	O.	(Else Poulsen × Break o'Day) H. Poly. I 3x H.T.	1944	"
Schleswig (syn. Maid of Honour)	" "	O.	(Holstein × Crimson Glory) H. Poly. II H.T. 4x	1948	"
R. W. Proctor	" "	O.	(Sport of A. M. Poulsen) H. Poly. II	1949	Proctor
Poulsen's Supreme	" "	O.		1950	Poulsen
Pink Anne	" "	O.	(Sport of A. M. Poulsen) H. Poly. II	1951	Cant
			Section III: H. Polys. derived, in part, from *R. Wichuraiana*		
(i) *Diploid*					
Yvonne Rabier	14[1]	T., W.	(*R. Wichuraiana* × a Dw. Poly.)	1910	Turbat
Ellen Poulsen	" "	T.	(Mme. N. Levavasseur × Dorothy Perkins) Dw. Poly. 2x H. Wich.	1911	Poulsen
Mrs. Dudley Fulton	" [9]			1931	Thomas
(ii) *Triploid*					
Poulsen's Copper	21[1]	Wheatcroft	(Ellen Poulsen × Mevrouw G. A. van Rossem) H. Poly. III 2x H.T.	1940	Poulsen
Frensham	" "	T., W.	((Edith Cavell × Edgar Andreu) Dw. Poly. H. Wich. × Crimson Glory) H.T. 4x	1946	Norman
Pinkie	" "	O.	(China Doll × unknown) H. Poly. III	1947	Swim

TABLE 1 (*Continued*)

Variety	Chr. no.	Source of material	Origin	Date of introduction & Breeder
(iii) *Tetraploid*				
Dance of Joy	28 [1]	Kordes	(Paul's Scarlet × Joseph Guy) H. Wich. 3x H. Poly.	1931 Sauvagoet
Chatter	" "	O.	(Minna Kordes × B. Prior) H. Poly. III H. Poly. II	1947 Boerner
Margraten	" "	O.	(M. Kordes × D. Prior) H. Poly. III H. Poly. II 4x	1949 Leenders
The Mountie	" "	O.	(M. Kordes × Springtime) H. Poly III H. Poly.	1949 Eddie
	Section IV: H. Polys. derived, in part, from *R. rugosa*			
(i) *Diploid*				
Pink Grootendorst	14 [1]	T.	(Sport of F. J. Grootendorst) H. Poly. IV	1925 Grootendorst
(ii) *Triploid*				
Bright Eyes [(5)]	21 [1]	O.	((Heidekind × B. Uprichard) × Joanna Hill) H. Poly. IV H.T. H.T.	1947 Duehrsen
	Unclassified (no information about origin)			
Pompon Beauty	28 [1]	O.		1949 de Ruiter
Border Queen	" "	O.		1950 " "
Red Butterfly	" "	O.		
Rosette	" "	O.		
HYBRID MUSK ROSES				
(i) *Diploid*				
Trier	14 [12]		(Aglaia × ? Mrs. R. G. Sharman Crawford) Nois. H.P.	1904 Lambert

TABLE 1 (*Continued*)

Variety	Chr. no.	Source of material	Origin	Date of introduction & Breeder	
Danaë	14 [1]	T.	(Trier × ? Gl. de Ch. Guinoisseau) H. Ms. 2x H.P.	1913	Pemberton
Cornelia	" "	T.		1925	"
Robin Hood	" [12]		(172/11 × E. Cavell) Dw. Poly.	1927	"
(ii) *Triploid*					
Pax	21 [1]	T.	(Trier × Sunburst) H. Ms. 2x H.T.	1918	Pemberton
Prosperity	" "	T.	(Marie-Jeanne × Perle des Jeannes) Dw. Poly.	1919	"
Vanity	" "	T.	(172/11 × Chât. de Clos Vougeot) H.T.	1920	"
Nur Mahal	" "	T.	" × " " " "	1923	"
Francesca	" "	T.	(Danaë × Sunburst) H. Ms. 2x H.T.	1922	"
Penelope	" "	T.	(Ophelia × seedling) H.T. 4x	1923	"
Gwyneth [6]	" "	T.	(Sport of (Trier × Rayon d'Or) H. Ms. 2x H.T. × sport of (G. Keller × Entente Cordiale)) H.T. H.T.	1923	Woosnam
Felicia	" "	T.	(Trier × Ophelia) H. Ms. 2x H.T. 4x	1928	Pemberton
Buff Beauty	" "	T.			
(iii) *Tetraploid*					
Eva	28 [1, 12]	Chaplins	(R. Hood × J. C. Thornton) H. Ms. 2x H.T.	1933	Kordes
Wilhelm	" [1]	T.	" " × " " "	1934	"

TABLE 1 (*Continued*)

Variety	Chr. no.	Source of material	Origin	Date of introduction & Breeder
Hamburg	28 [1, 12]	T.	(Eva × Daily Mail) H. Ms. 4x H.T.	1935 Kordes
Sangerhausen	" [1]	T.	(I. Olsson × Eva) H. Poly. II H. Ms. 4x	1938 "
Pinocchio (syn. Rosenmärchen)	" "	O.	(Eva × Geh. Duisberg) H.T.	1940 "
Will Scarlet	" "	T.	(Sport of Wilhelm) H. Ms. 4x	1950 Hillings
FLORIBUNDA ROSES (Varieties of mixed H. Poly., H. Musk and sometimes H. Rubiginosa origin)				
(i) *Triploid*				
Elfe	21 [1]	O.	(Swantje × Hamburg) H. Poly. III H. Ms. 4x	1945 Tantau
De Ruiter's Herald	" "	Wheatcroft	(Orange Triumph × unknown) Fl.	1948 de Ruiter
Elmshorn	" "	O.	(Hamburg × Verdun) H. Ms. 4x Dw. Poly.	1951 Kordes
Baby Triumph	" "	O.	(Orange Triumph × M. Koster) Fl. Dw. Poly.	
(ii) *Tetraploid*				
Goldene Johanna Tantau (syn. Wheatcroft's Golden Poly.)	28 [1]	Wheatcroft	(Geh. Duisberg × (J. Tantau × E. Lamesch)) H.T. Dw. Wich. Dw. Poly.	1945 Tantau
Goldilocks	" "	O.	(Doubloons × ((climber × Dazla) H. Setigera H.T. × Doubloons)))	1945 Boerner
Fashion	" "	O.	(Pinocchio × Crimson Glory) H. Ms. 4x H.T. 4x	1947 Boerner
Vogue	" "	O.	" × " "	1947 "

TABLE 1 (*Continued*)

Variety	Chr. no.	Source of material	Origin	Date of introduction & Breeder
Red Pinocchio	28[1]	O.	(Yellow Pinocchio (Fl. 4x) × D. Prior (H. Poly II 4x))	1947 Boerner
Alain	" "	Wheatcroft	((Guinée (Cl. H.T.) × Wilhelm (H. Ms. 4x)) × Orange Triumph (Fl.))	1948 Meilland
Berlin	" "	O.	(Peace (H.T. 4x) × Eva (H. Ms. 4x))	1949 Kordes
La Ramée	" "	O.	(Holstein (H. Poly II) × Alain (Fl. 4x))	1949 Meilland
Masquerade	" "	O.	(Goldilocks (Fl. 4x) × Holiday (Fl.))	1949 Boerner
Our Princess	" "	O.	(Orange Triumph (Fl.) × D. Prior (H. Poly II 4x))	1949 Robinson
Signal Red	" "	O.	(De Ruiter's Herald (Fl. 3x) × polyantha seedling)	1949 de Ruiter
Bonn	28 + fragment[1]	O.	(Hamburg (H. Ms. 4x) × Sondermeldung (Fl. 4x))	1950 Kordes
Kordes' Sondermeldung (syn. Independence)	28[1]	O.	(Baby Château (Fl.) × Crimson Glory (H.T. 4x))	1950 "
Florence Mary Morse	" "	O.	(Obergärtner Wiebicke (Fl.) × Else Poulsen seedling (H. Poly. I 3x))	1950 "
Tapis Rose	27[1]	O.	(Pinocchio (H. Ms. 4x) × Mme. J. Gouchault (Dw. Poly.))	1950 Meilland
Yellow Pinocchio	28[1]	O.	(Goldilocks (Fl. 4x) × Marionette (H. Ms.))	1950 Boerner
Cocorico	" "	O.	(Orange Triumph (Fl.) × Alain (Fl. 4x))	1951 Meilland
Cinnabar Improved[(7)] (syn. Verbesserte Tantau's Triumph)	" "	O.	((Cinnabar (Fl.) × Käthe Duvigneau (Fl.)) × Cinnabar)	1951 Tantau

TABLE 1 (*Continued*)

Variety	Chr. no.	Source of material	Origin	Date of introduction & Breeder	
Grandmaster	28[1]	O.	(Sangerhausen × Sunmist) H. Ms. 4x H. Poly	1951	Kordes
Rudolph Timm	" "	O.	(Obergärtner Wiebicke × Baby Château) Fl. Fl.	1951	"
Tantau's Delight	" "	O.	(Cinnabar × Käthe Duvigneau) Fl. Fl.	1951	Tantau
HYBRID RUGOSA ROSES					
(i) *Diploid*					
Frau Dagmar Hartopp	14[1]	T.			
Mme. Georges Bruant	" "	W.	(*R. rugosa* × Sombreuil) Tea	1887	Bruant
Belle Poitevine	" "	W.		1894	"
Roseraie de l'Hay	" "	T.	(Sport of *R. rugosa rosea*)	1901	Cochet-Cochet
Schneezwerg	" "	T.	(*R. rugosa* × *R. multiflora*)	1912	Lambert
Max Graf	" [11]		(*R. rugosa* × *R. Wichuraiana*)	1919	Bowditch
Sarah van Fleet [(8)]	" [1]	T.	(*R. rugosa* × ? My Maryland) H.T.	1926	van Fleet
(ii) *Triploid*					
Mrs. Anthony Waterer	21[1]	Notcutts	(Gén. Jacqueminot × rugosa hybrid) H.P. 4x	1897	Waterer
Agnes	" "	T.	(*R. rugosa* × *R. foetida persiana*)	1900	Saunders
Rose à Parfum de l'Hay	" "	T.	((*R. damascena* × Gén. Jacqueminot) H.P. 4x × *R. rugosa germanica*)	1903	Gravereaux
Ruskin	" "	T.	(*R. rugosa* × Victor Hugo) H.P.	1928	van Fleet

TABLE 1 (*Continued*)

Variety	Chr. no.	Source of material	Origin	Date of introduction & Breeder
(iii) *Tetraploid*				
Conrad Ferdinand Meyer	28 [1, 6, 10]	W.	((Gloire de Dijon × Duc de Rohan) Nois. 4x H.P. × *R. rugosa germanica*)	1899 Muller
Carmenetta	" [1]	T.	(*R. rubrifolia* × *R. rugosa*)	1920 Preston
Dr. Eckener	" [3]		(*rugosa* seedling × Golden Emblem) H.T.	1931 Berger
KORDESII ROSES				
R. Kordesii	28 [11]		(Max Graf seedling) H. Rug. 2x	1940 Kordes
Seedling 167/45/15	" [1]	O.	(*R. Kordesii* × Golden Glow) H. Wich.	"
HYBRID RUBIGINOSA ROSES				
(i) *Tetraploid*				
Rosenwunder	29 [1]	T.	(W. E. Chaplin × *R. rubiginosa magnifica*) H.T. 5x	1934 Kordes
(ii) *Pentaploid*				
Catherine Seyton	35 [7]			1895 Penzance
R. rubiginosa magnifica	" [1]	Kordes	(Lucy Ashton seedling) H. Rubig. 6x	1916 Hesse
(iii) *Hexaploid*				
Janet's Pride	42 [1]	T.		
Lady Penzance	" [1, 7]	T.	(*R. rubiginosa* × *R. foetida bicolor*)	1894 Penzance
Lucy Ashton	" [1]	W.		1895 "
Refulgence	41 [1]	T.		1909 Paul

TABLE 1 (*Continued*)

Variety	Chr. no.	Source of material	Origin	Date of introduction & Breeder
HYBRID SPINOSISSIMA ROSES				
Stanwell Perpetual	28 [1]	T.	(*R. spinosissima* × ?*R. damascena*)	1838 Lee
Harison's Yellow	" [1,4]	B.	(*R. spinosissima* × *R. foetida*)	1830 Harison
Rustica	" [1]	T.	(Mme. É. Herriot (H.T. 4x) × Harison's Yellow)	1929 Barbier
Frühlingsgold	" "	T.	(J. Hill (H.T.) × *R. spinosissima hispida*)	1937 Kordes
Frühlingsmorgen	" "	T.	((C. Kordes (H.T.) × E. G. Hill (H.T.)) × *R. spinosissima altaica*)	1941 "
HYBRID WICHURAIANA ROSES				
(i) *Diploid*				
Alberic Barbier	14 [1]	B.	(*R. Wichuraiana* × S. Hibberd (Tea))	1900 Barbier
Excelsa	" "	B.		1908 Walsh
(ii) *Triploid*				
American Pillar	21 [1]	B.	(*R. Wichuraiana* × *R. setigera* × red H.P.)	1905 van Fleet
Dr. W. van Fleet	" "	Wheatcroft	(*R. Wichuraiana* × Souv. du Prés. Carnot (H.T.))	1910 " "
Emily Gray	" "	"	(Jersey Beauty (H. Wich.) × Comtesse du Cayla (China))	1916 Williams
Paul's Scarlet Climber	" "	B.	(*R. Wichuraiana* × unknown)	1916 Paul
New Dawn	" "	T.	(Sport of Dr. W. van Fleet (H. Wich. 3x))	1930 Dreer
(iii) *Tetraploid*				
Chaplin's Pink Climber	28 [1]	Wheatcroft	(Paul's Scarlet (H. Wich. 3x) × American Pillar (H. Wich. 3x))	1929 Chaplin

TABLE 1 (*Continued*)

Variety	Chr. no.	Source of material	Origin	Date of introduction & Breeder	
Dream Girl	28 [1]	T.	(Dr. W. van Fleet × Senora Gari) H. Wich. 3x H.T.	1944	Jacobus
CLIMBING MULTIFLORA ROSES					
(i) *Diploid*					
Crimson Rambler	14 [7]			1894	Turner
Phyllis Bide	" [1]	B.		1924	Bide
(ii) *Tetraploid*					
De la Grifferaie [(9)]	28 [1]	T.		1845	Vibert
ARVENSIS, SEMPERVIRENS and SINOWILSONII HYBRIDS					
Miss Jekyll	14 [1]	K.	(*R. arvensis* × ? *R. chinensis*)		
Little White Pet	" "	T.	(*R. sempervirens* × ? *R. moschata*)	1879	
Wedding Day [(10)]	" "	S.	(*R. sinowilsonii* × unknown)	1949	Stern
HYBRID BRACTEATA ROSES					
Marie Leonida	14 [1]	T.	(*R. bracteata* × *R. laevigata*)	1829	Lemoine
Mermaid	" "	Wheatcroft	(*R. bracteata* × double yellow Tea Rose)	1918	Paul
HYBRID GIGANTEA ROSES					
(i) *Diploid*					
La Follette	14 [1]	T.		c. 1900	Bushby
(ii) *Triploid*					
Belle Portugaise [(11)]	21 [1]	T.	(*R. odorata gigantea* × Reine M. Henriette, or Souv. de L. Viennot) both Teas	1903	Cayeux

TABLE 1 (*Continued*)

Variety	Chr. no.	Source of material	Origin	Date of introduction & Breeder
BOURSALT ROSES				
Rubra	14[1]	S.	(*R. chinensis* × *R. cinnamomea*)	
HYBRID MACRANTHA ROSES				
Lady Curzon	21[1]	T.	(*R. macrantha* 4x × *R. rugosa* 2x)	1901 Turner
Raubritter	" "	T.	(*R. macrantha* Daisy Hill × Solarium H. Wich.)	1936 Kordes
NUTKANA HYBRID				
Cantab	35[1]	O.	(*R. nutkana* 6x × Red Letter Day H.T. 4x)	1939 Hurst
CINNAMOMEAE HYBRID				
Nevada	28[1]	S., T.	(La Giralda H.T. × ? a 4x species allied to *R. moyesii*)	1927 Dot

FOOTNOTES TO TABLE 1

(1) Although Hurst (1929) reported "Mme. Alfred Carrière" as having 28 chromosomes, the plant I examined, about whose identity there would not appear to be any doubt, proved to be a triploid. This discrepancy is difficult to explain at present.

(2) The pedigree reported for the old variety "Gruss an Aachen" is probably incorrect, since it is a triploid. It has sometimes been classified as a "Polyantha" but its place would seem to be rather with the triploid Hybrid Teas.

(3) "Mme. de Tartas," the Tea rose recorded as one parent of the tetraploid "Mme. Caroline Testout," is itself almost certainly a diploid, since it is also reported as one parent of the diploid "Mlle. Marie van Houtte." Presumably therefore, if the reported origin is correct, an unreduced gamete from "Mme. de Tartas" took part in this cross. The same applies to "Gustav Grunerwald," since "Safrano," too, is probably one of the diploid Teas, from the evidence of its progeny.

(4) Since "Cramoisi Superiere" is a triploid, it seems unlikely that it was a parent of the diploid "Éblouissant." Diploid crimson Chinas are known (Hurst 1941) and one of these may perhaps have been a parent.

(5) The pedigree reported for "Bright Eyes" seems unlikely, since this variety is a triploid. (Heidekind × Betty Uprichard) would no doubt produce a triploid and on crossing again to a H.T. one would expect a tetraploid, as has happened in the other groups.

(6) "Gwyneth" seems better placed with these older Hybrid Musks, rather than with the Dwarf Polyanthas (its usual classification), both on account of its origin from "Trier" and its triploid chromosome number.

(7) "Tantau's Triumph" (syn. "Cinnabar") is reported to have the diploid species *R. Roxburghii* as one parent. However one must consider this doubtful, since this species is in a separate subgenus of its own and one would anticipate that the triploids derived from crossing it with the ordinary garden roses would be very sterile. Its direct descendants, "Cinnabar Improved" and "Tantau's Delight," are both tetraploids, although *both* the parental varieties should have been triploids if their reported origins are correct. It is therefore most likely that "Cinnabar" itself is also a tetraploid (and did not have *R. Roxburghii* as one parent). I hope to check this when I have an opportunity of collecting material from this variety. (*See Wulff, page 73.—Ed.*)

(8) "Sarah van Fleet" is a diploid, although the H.T. "My Maryland" is given as one parent by the raiser. Since this is probably a tetraploid, this origin is doubtful and the second parent of the variety may perhaps have been one of the diploid Teas, which Van Fleet used extensively in his breeding work.

(9) I have followed tradition in placing the ancient variety "De La Grifferaie" with the Climbing Multifloras, although its tetraploid chromosome number as well as its appearance sets it apart from the others in this group.

(10) Since the new *R. sinowilsoni* hybrid "Wedding Day" is a diploid, the male parent cannot have been *R. moyesii* (hexaploid) as was at one time thought.

(11) The Tea rose parent of the triploid "Belle Portugaise" was perhaps one of the tetraploids in this group. One can infer that "Reine Marie Henriette," at any rate, is likely to have been a tetraploid, since it is descended from the tetraploid "Gloire de Dijon" and is recorded as having only 5% good pollen by von Rathlef (1937), in contrast to the diploid Teas, which are very fertile.

The cytological studies of Täckholm, Erlanson and Hurst (see Hurst, 1929) have demonstrated that polyploidy is a feature of the genus *Rosa* and species with up to 56 chromosomes (octoploid) are known. However, none of the high polyploid species has been important in the ancestry of the cultivated roses. Many of these ancestors are, in fact, diploids as this list shows:

Section	*Species*	*Chromosome number*
CHINENSES *	*R. chinensis*	14
	R. gigantea	14
SYNSTYLAE	*R. moschata*	14
	R. multiflora	14
	R. Wichuraiana	14
GALLICANAE	*R. gallica*	28
	R. damascena	28
PIMPINELLIFOLIAE	*R. foetida*	28

Various other species, of course, have played a lesser role, but the ones listed, as Hurst (1941) showed, are most important.

The table shows that the modern garden roses have not progressed beyond the tetraploid level of some of their ancestral species. The exceptional varieties with a higher degree of polyploidy, such as the *R. nutkana* and some of the *R. rubiginosa* hybrids, owe this to their hexaploid or pentaploid parental species.

The steps from diploidy to triploidy and, more frequently, from triploidy to tetrapolidy, have occurred independently in several groups. The China roses (developed from *R. chinensis*), the Noisettes and Teas (from *R. chinensis, R. gigantea* and *R. moschata*) were all diploids originally, but polyploidy occurs in some of the subsequent varieties in all three groups. Only triploids have been found so far among the China varieties and one of these, "Hermosa," should perhaps be classed with the Bourbons (Hurst, 1941). But in the Noisettes and Teas, both triploids and tetraploids are known. "Gloire de Dijon" has been classed with both the Teas and Noisettes, but it is derived in

* Rehder, the accepted standard of the American Rose Society publications, gives this as INDICAE. Ed.

part from the triploid Bourbon "Souvenir de la Malmaison," to which its tetraploidy is due. Most of the other polyploid Teas are related to "Gloire de Dijon" or to one of the Bourbon class, themselves all polyploids.

The Bourbons (Autumn Damask and *R. chinensis* in the first place) and also the Hybrid Chinas (originally from *R. gallica* and *R. chinensis*) started as triploids, but tetraploids eventually arose in both through, it seems, crossing the less sterile triploids with the tetraploid European roses. The Hybrid Perpetuals were derived chiefly from these later, tetraploid Hybrid Chinas, Bourbons and also the ancient Portland roses, developed from the Autumn Damasks, and all the varieties examined are themselves tetraploid. Fig. 6 shows the 28 chromosomes of "Général Jacqueminot," during meiosis before pollen grain formation. The number of chromosome pairs (bivalents) varies from cell to cell; in this one there are nine bivalents and the other 10 chromosomes are present as three unpaired chromosomes (univalents), one association of four and one of three, the result probably of interchanges of chromosome segments, described previously for roses by Erlanson and Wulff.

The next major group of garden roses, the Hybrid Teas, were originally triploid, being derived from crossing the tetraploid Hybrid Perpetuals and the diploid Teas, and therefore rather sterile. But here again tetraploids had arisen by 1890, following crosses with other tetraploid varieties, either Hybrid Perpetuals or the later, tetraploid Teas. The use of *R. foetida* by Pernet-Ducher at the beginning of this century did not lead to any changes in the ploidy of the Hybrid Teas, since this "species" is also a tetraploid. The succeeding fifty years of Hybrid Tea development have taken place at the tetraploid level. Fig. 7 shows the 28 chromosomes of "Crimson Glory" at first metaphase of meiosis. This cell contains seven bivalents and three associations of four chromosomes. Most cells, however, have more bivalents than this and segregation generally leads to the formation of gametes containing 14 chromosomes.

The Dwarf Polyantha group, originally from *R. chinensis* and *R. multiflora,* have remained entirely diploid, like the ancestral

species. So when Poulsen started the Hybrid Polyantha class, with crosses between Hybrid Teas and Dwarf Polyanthas, the original members were triploid. These primary hybrids have been separated as Section I (following Lammerts' classification of the group (1947)). Many of these triploid Hybrid Polyanthas are highly sterile and further breeding has been possible only from a relatively small number of varieties. The least sterile one so far has been "Else Poulsen," whose chromosomes are shown in figs. 1 and 2. The maximum degree of association is shown in fig. 1, with its seven trivalents, while the opposite extreme is found in fig. 2, with only one trivalent and six univalents. Most cells have three or four trivalents. Germ cells containing every chromosome number from seven to 14 can be formed, but from the selected progeny of "Else Poulsen" (and the other triploids used) we have evidence so far only for the functioning of the 14-chromosome class, since section II of the Hybrid Polyanthas (derived from back-crossing the triploid original hybrids to the tetraploid Hybrid Teas) has been found to contain only tetraploids up till now. "Poulsen's Pink" has been placed in this section on the evidence of its tetraploid chromosome number, although the reported pedigree (which must be considered doubtful) is that of a section I hybrid.

Section III (those Hybrid Polyanthas derived, in part, from *R. Wichuraiana*) contains diploid, triploid and tetraploid varieties and in section IV (those with *R. rugosa* as one ancestor), diploids and triploids have been found. Tetraploids no doubt exist here also, from the pedigrees reported.

The old Lambert and Pemberton hybrids are commonly called Hybrid Musks, since *R. moschata,* through the Noisette "Aglaia," has been primarily responsible for introducing the cluster-flowered habit and, with *R. chinensis,* the long flowering season to this group of varieties. As Wulff and Heldt (1953) suggest, "Trier" (one parent of practically all the old Hybrid Musks) is probably a selfed seedling from "Aglaia," since it is a diploid and not the triploid expected if the pedigree reported by Lambert were correct. Similarly the pedigree reported for "Danaë" is probably wrong; it, too, may be "Trier" selfed.

There are, however, quite a lot of triploid Hybrid Musks from genuine crosses of "Trier" (or its seedlings) with, generally, Hybrid Teas. Then in the early 1930's, Kordes revived interest in the group and he produced the first tetraploid, "Eva," and from this have come many others. "Eva" (and its sister seedling, "Wilhelm," also tetraploid) have the diploid "Robin Hood" as one parent. This must have contributed unreduced gametes to these varieties, if the pedigree reported is correct.

These tetraploid Hybrid Musks were soon crossed with Hybrid Polyantha varieties, so that a group of very mixed origin has recently come into existence, now generally known as Floribundas.† A few of these are triploids, but the vast majority are tetraploid, like the Hybrid Teas and later Hybrid Polyanthas, facilitating hybridization between them all.

One of the very rare aneuploid garden varieties belongs to the Floribundas. This is "Tapis Rose," which has only 27 instead of 28 chromosomes, as a result, no doubt, of one of the parental gametes having 13, not 14, chromosomes. Such gametes must be formed not infrequently in most tetraploid varieties (along with others containing 12, 15 or 16 chromosomes) following the irregularities observed during meiosis, but "Tapis Rose" is the only variety so far discovered in whose origin one of these unbalanced gametes has taken part. Its chromosomes are shown in fig. 8, where there are 11 bivalents, one association of four chromosomes and one univalent.

"Bonn," another Floribunda variety, is also noteworthy. It has a much smaller 29th chromosome, in addition to the normal 28, which is considerably less than half the size of any of the others. It behaves quite normally during ordinary cell division and so does not get lost. Figs. 4 and 5 show this minute extra chromosome. One of the triploid Hybrid Polyanthas, "Poulsen's Crimson," has a similar supernumerary chromosome (fig. 3). They have also been found in some of the wild varieties of *R.*

† In the United States, the name Floribunda is very loosely used as a synonym for Hybrid Polyantha and does not generally have this connotation. Ed.

spinosissima. The origin of such supernumerary chromosomes is probably to be traced back to irregularities during meiosis.

Kordes' modern Sweet Briar hybrids are interesting from the cytological viewpoint. The ancestral *R. rubiginosa,*‡ a pentaploid with the Canina type of meiosis, produces pollen grains with 7 chromosomes and egg cells with 28. When, therefore, Penzance made his crosses using the tetraploid Hybrid Perpetuals and *R. foetida* as male parents at the end of last century, the hybrids produced were hexaploid. The starting point for Kordes' work was a seedling from one of these hexaploids, "Lucy Ashton," named *R. rubiginosa magnifica* by Hesse in 1916. This derivative is a pentaploid, which is not surprising since meiosis in the Penzance briars is very irregular and leads to considerable chromosome loss during gamete formation. Meiosis is also irregular in *R. rubiginosa magnifica* itself, with a high univalent frequency. It is not unexpected, therefore, to find tetraploids appearing in the progeny from crosses of this pentaploid with the tetraploid Hybrid Teas and Hybrid Polyanthas. Actually "Rosenwunder," the only one of the direct "Magnifica" hybrids examined, is an aneuploid with $2n = 29$. The later hybrids available for examination, "Florence Mary Morse" and "Rudolph Timm," are both exact tetraploids. In the development of these modern Hybrid Sweet Briars there has been a *lowering* of the level of polyploidy from hexaploid to tetraploid.

Kordes' recent *R. spinosissima* hybrids are more straightforward, since *R. spinosissima* is itself a tetraploid and when crossed with the Hybrid Teas has produced tetraploid hybrids with a reasonably regular chromosome behavior at meiosis and high pollen fertility.

The Hybrid Rugosas are mainly diploid or triploid, with a very few tetraploids only. The triploids in this group are excessively sterile and form no good pollen at all. *R. rugosa* belongs to quite a different section of the genus, the Cinnamomeae, and the degree of homology between its chromosomes and those of the sections Chinenses and Synstylae appears to be slight. So the usual method by which tetraploids have been obtained in the

‡ Rosa Eglanteria, Linnaeus.

other groups, that is, through triploid-tetraploid crosses, has not been possible in the Hybrid Rugosas. The old tetraploid "Conrad Ferdinand Meyer" (1899) probably arose through the functioning of an unreduced *rugosa* gamete (that is, one with the full 14 chromosomes, instead of the normal 7), since there is evidence from other sources that *R. rugosa germanica* is a diploid, like *R. rugosa* itself.

The only documented case in the genus, however, of the origin of a tetraploid through chromosome doubling occurred in 1940 in the sterile diploid rugosa hybrid, "Max Graf" (Wulff, 1951). This produced the fertile tetraploid named *R. Kordesii.* Attempts to double chromosomes artificially in roses, using colchicine, have been discouraging so far, but it should be possible to develop a suitable technique. Through the use of the original *R. Kordesii* and its subsequent hybrids, it will now be possible for *R. rugosa* genes to participate in garden rose development to a much greater extent than in the past. Fig. 9 shows the 28 chromosomes of one of Kordes' seedlings on trial at "Oaklands"; it comes from *R. Kordesii* crossed with the Wichuraiana hybrid "Golden Glow." Meiosis is reasonably regular, the cell illustrated having eight bivalents, two associations of four chromosomes, one of three and one univalent.

The Hybrid Wichuraiana group, which contains the principal modern rambler varieties, also consists of diploids, triploids and tetraploids. Some of the triploids, such as "Dr. Walter van Fleet," are only partially sterile, since *R. Wichuraiana* is one of the Synstylae, with chromosomes essentially homologous to those of the other main ancestral species. It has been possible, therefore, to use the Hybrid Wichuraianas in breeding hardy Hybrid Teas.

Only two other varieties in the list need be mentioned. The first is Hurst's *R. nutkana* hybrid, "Cantab," which has the anticipated 35 chromosomes (*R. nutkana* being a hexaploid). There are a good many univalents present at meiosis and one would expect that tetraploids would be obtained in fair numbers from further crossing to tetraploids, as happened with Kordes' rubiginosa hybrids. So far, however, "Cantab" has been neglected by breeders.

The other variety is "Nevada." This has been widely regarded as a *R. Moyesii* hybrid, following the statement of its raiser, P. Dot, that it was a cross between "La Giralda" (a hybrid from "Frau Karl Druschki" and "Mme. Edouard Herriot," both known tetraploids, so that "La Giralda" is very probably also tetraploid) and the hexaploid *R. Moyesii.* One would therefore expect it to be a pentaploid, like "Cantab." But such is not the case, "Nevada" being a tetraploid. However, it is obviously not an ordinary Hybrid Tea, such as one might expect if "La Giralda" had been accidentally selfed, instead of crossed with *R. Moyesii.* One can only surmise, for the time being, that the male parent was, not *R. Moyesii* itself, but one of its tetraploid allies, of which there are several, such as *R. Fargesii* and *R. Davidii.* It is desirable to repeat this type of cross and work on these lines is in progress. For the Oriental Cinnamomeae, as Hurst pointed out in 1929, have much to offer the rose breeder and they have been entirely neglected up till now.

SUMMARY

The chromosome numbers of the 234 garden rose varieties given in the preceding table may be summarized as follows:

Group	2x	3x	4x	5x	6x	Total
China	11	2	..	..	..	13
Noisette	8	2	1	..	..	11
Tea	6	6	1	..	..	13
Bourbon	..	4	4	..	..	8
Hybrid China	..	1	4	..	..	5
Portland & Hybrid Perpetual	..	..	9	..	..	9
Hybrid Tea	..	3	25	..	..	28
Dwarf Polyantha	13	..	..	..	..	13
Hybrid Polyantha	4	14	20	..	..	38
Hybrid Musk	4	9	6	..	..	19
Floribunda	..	4	21	..	..	25
Hybrid Rugosa & Kordesii	7	4	5	..	..	16
Hybrid Wichuraiana	2	5	2	..	..	9
Hybrid Spinosissima	..	..	5	..	..	5
Hybrid Rubiginosa	..	..	1	2	4	7
10 minor groups	9	3	2	1	..	15
Total	64	57	106	3	4	234

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LEGENDS TO FIGURES

All drawings are of various stages of meiosis in the pollen mother cells of triploid and tetraploid rose varieties. Magnification approximately 2,000 times.

FIGS. 1 AND 2. First metaphase in "Else Poulsen" ($2n = 3x = 21$), showing the extremes found in chromosome association : in fig. 1, 7 trivalents, in fig. 2, only 1 trivalent, 6 bivalents (in outline) and 6 univalents.

FIG. 3. First anaphase in "Poulsen's Crimson," a triploid with one additional, very small chromosome. There are 11 chromosomes at one pole, 9 at the other, with one ordinary univalent and the 22nd chromosome, both starting to divide at the equator.

FIGS. 4 AND 5. The tetraploid Floribunda, "Bonn," also has a minute extra chromosome. Fig. 4: first anaphase with 13 chromosomes passing to each pole and two normal chromosomes together with the supernumerary present as univalents at the spindle equator. One association of four, one of three, three univalents and nine bivalents (in outline). Fig. 5: first metaphase with the extra chromosome as a univalent (on the extreme right of the cell) and the 28 ordinary chromosomes forming one association of four, 11 bivalents (in outline) and 2 univalents.

FIG. 6. First metaphase in the old H.P. "Général Jacqueminot" ($2n = 4x = 28$).

FIG. 7. First metaphase in the H.T. "Crimson Glory" ($2n = 4x = 28$). Three associations of 4, 2 univalents and only 7 bivalents.

FIG. 8. First metaphase in the Floribunda, "Tapis Rose," the only hypotetraploid found ($2n = 4x - 1 = 27$). One association of 4, one univalent and 11 bivalents.

FIG. 9. First metaphase in a tetraploid seedling from (*R. Kordesii* × "Golden Glow"). Two associations of four, one of three, one univalent and eight bivalents.

APPENDIX

A note on the cytological methods used

For somatic chromosome counts, root tips (from cuttings), stem tips and very young petals or ovules have been used. These were pretreated for 2–2½ hours in *para-dichlorobenzene* (Meyer, 1945), plus. 0.01% of sodium lauryl sulphate to ensure penetration of the pretreating agent.

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This treatment interrupts the course of mitosis just before metaphase, through interfering with normal spindle development, so that the chromosomes remain conveniently scattered about the cell, instead of being arranged in a compact plate, and, in addition, they contract more than usual. Chromosome counting, even in the higher polyploids, is thus made very much easier than in untreated material.

Rinsing in water was followed by fixation in acetic alcohol (1 : 3) overnight. It was found necessary to prolong hydrolysis (preparatory to staining in the Feulgen reagent) to three or four times the usual period after alcoholic fixation. Adequate staining with Feulgen was generally obtained after hydrolysis in normal hydrochloric acid at 60–62° C for half an hour. The meristematic parts were subsequently squashed in either 45% acetic acid or aceto-carmine, if it was desired to intensify the stain.

For the study of meiosis in the pollen mother cells, buds of the right age were stripped of their sepals and petals and then fixed in either (i) Thomas' (1940) fixative developed for plants with small chromosomes, that is, 3 parts of absolute alcohol and 1 part of glacial acetic acid saturated carmine, plus 3 drops of ferric acetate (saturated solution in glacial acetic acid) to every 10 cc., or (ii) ordinary acetic alcohol, plus a small amount of 2% aqueous ferric chloride, so that the final solution is just straw colored. Both gave, on the whole, satisfactory results. Fixation times were up to five days for the first method and overnight for the second. Fixation was considerably improved if carried out in a refrigerator at about 0° C. After fixation, the buds were transferred to absolute alcohol for one or two days, then hydrolysed for six minutes in *N* HCl at 60-62° C and stained in Feulgen. Hydrolysis was found necessary in order to get the pollen mother cells properly isolated from one another. Subsequently, individual anthers were squashed in aceto-carmine in the usual way.

If the temporary slides were sealed with vaseline and kept in the refrigerator, they remained in good condition for as long as four months. Slides can be made permanent (see Darlington and La Cour, 1947), but there is nearly always some darkening of the cytoplasm and consequent loss of contrast between this and the chromosomes. Observations, drawings and photographs are therefore better made on the temporary preparations.

References

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